22ND FECAVA
Eurocongress

31. VÖK Jahrestagung
31ST VOEK Annual Meeting

22–25 June 2016
Hofburg, Vienna

www.fecava2016.org

Proceedings
22. FECAVA Eurocongress

31st Annual Congress of the Association of Austrian small animal veterinarians

Endoscopic Surgery

Hofburg, Vienna
June 22 - 25, 2016
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speakers</td>
<td>4</td>
</tr>
<tr>
<td>Laparoscopy and thoracoscopy: How to get started</td>
<td>5</td>
</tr>
<tr>
<td>Laparoscopic sterilization</td>
<td>9</td>
</tr>
<tr>
<td>15 Years of Veterinary Interventional Radiology: Lessons Learned</td>
<td>12</td>
</tr>
<tr>
<td>Interventional endoscopy (1)</td>
<td>20</td>
</tr>
<tr>
<td>Interventional endoscopy (2)</td>
<td>24</td>
</tr>
</tbody>
</table>
Univ. Prof. Dr. Gilles Dupré, Dipl. ECVS
Austria

------------------------------------------------------------------------------------------------------------

Prof. Dr. med. vet. Gerhard Oechtering, DipECVAA
Germany
Email: oechtering@vetmed.uni-leipzig.de

------------------------------------------------------------------------------------------------------------

Staff Surgeon Chick (Charles) Weisse
Director of Interventional Radiology Services
USA
Email: chick.weisse@gmail.com
Introduction

In 1806 Bozzini, an obstetrician from Frankfurt, using a candlelight through a tube attempted to examine urethra and vagina, and really started with endoscopic examinations. In 1901 Kelling from Dresden reported the first laparoscopic examination of a dog’s cavity. Ten years later, Jacobaeus from Stockholm performed the first human laparoscopies and thereafter thoracoscopy to section pleural adhesions. In 1987 Mouret and Dubois, in Lyon, successfully realized the first laparoscopic cholecystectomy. This gave the real start to Mini-invasive surgery.

The advantages of mini-invasive surgery have been described and usually comprise:

- Smaller incisions
- Better visions
- Less post-operative pain
- Shorter hospital stay

Mini-invasive surgery requires a specific material: A tilt able surgical table, a complete video setting with 0-30° laparoscope, a mono or three CCD camera and recording material. In the abdominal cavity an insufflator will also be used. An electrosurgical unit with uni and bipolar cautery for endoscopic instruments as well as irrigation and vacuum system are necessary. All types of endoscopic instruments must also be available: laparoscopic trocarts, endo-graspsers are widely used, endosutures and endo-ligatures as well as endo-clips and surgical staples are necessary for some procedures. Mini-invasive surgery requires a "working space" to be able to manipulate the instruments without damaging intra-cavitary organs. In laparoscopic surgery, this space is obtained by insufflating carbon dioxide into the abdominal cavity, creating a pneumoperitoneum. Monitoring the patient during the procedure is mandatory and requires an anesthetist (nurse or vet) and instrumental equipment: Spirometer, EKG, Pulse oxymetry and moreover capnograph. Finally, beside the list of instruments and setting, starting with mini-invasive surgery, requires
learning and experience. A new philosophy of surgery where the minimum morbidity is the rule must be gained and for this, hours, days and weeks of specific trainings are necessary.

**Current indications of laparoscopy and thoracoscopy in small animals**

- **Exploratory examination and biopsies**
  Several studies have been conducted and validate the superiority of laparoscopic-or thoracoscopy obtained biopsy samples compared to fine needle or ultra-sound guided biopsies. Liver, kidney, and spleen biopsies can be easily performed using a two or a one-hole laparoscopy. Intestinal biopsies are best made by laparoscopic-assisted technique. Lungs, pleurae and Lymph node biopsies can be made using biopsy forceps, suture or vessel-sealer.

- **Partial or total Organ ablation, drainage**
  Laparoscopy offers several advantages over conventional laparotomy for elective surgeries : Cryptorchietectomy, ovariection or ovario-hysterectomy. In several studies, post-operative behavior using behavior scales have validated the superiority of laparoscopic ovariection over regular ovariection. Besides the traditional 3 holes techniques, 2 and one-hole techniques have been described and offer great cosmetic advantages. Intra-abdominal removal of pathologic organs have also been performed : Cholecystectomy, adrenalectomy, pancreatic tumors…In the chest, thoracoscoptic pericardectomy offers major advantages over traditional trans-sternal or trans-thoracic approaches.

  Many other procedures have been performed : Colposuspension, Jejunostomy tube insertion, partial or total lung lobectomies, PDA closure, Ligamentum arteriosum removal, Thymomas removal…Drainage of intra-abdominal or intra-thoracic diseases can also be facilitated using a scope and a video monitor.

- **Other developments : Video-assisted procedures**
  Indications for laparoscopic-assisted are currently expanding. In these cases, the surgical approach is minimized thanks to the use of the video. A part of the procedure is actually being performed out of the natural cavity : Lap-assisted gastropexy, Lap-assisted cystotomy, Video-assisted thoracic surgery…

**Laparoscopy and thoracoscopy: is it for the practitioner?**

- **Does mini-invasive surgery presents any advantage to the patient?**
  On many elective surgeries (ovariection, ovario-hysterectomy, cryptorchietectomy) as well as on some specific procedures (pericardectomy) pain scores and behavior
scores have been shown to be in favor of mini-invasive approach. In other procedures validations are still lacking because of lack of sufficient number of cases. Nevertheless the trend is that mini approaches, if not detrimental to the patient, reduce pain and morbidity.

- What are the advantages for the owners?
The idea of mini-invasive surgery as well as the idea of offering the « state of the art technology » pushes the owners to ask for mini-invasive surgeries. They easily compare human surgery with veterinary surgery and expect for their pet what they want for themselves.

- Can the practitioner benefit from it?
Placing a scope into a cavity has brought over the years a tremendous amount of information. The practitioner willing to start with mini-invasive surgery should start with rigid endoscopic examination: Urethro-cystoscopy, Otoscopy, Rhinoscopy, Laryngo-pharyngoscopy, Bronchoscopy. Then, further progress can be achieved by performing intra-abdominal biopsies: Liver, Lymph node, Pancreas…Once this has been done, elective surgeries can be offered: Ovariectomy, Cryptorchietomy.

Conclusion
Over the past twenty years mini-invasive surgery has represented a major progress in diagnosis and treatment of surgical diseases. In small animal surgery, practitioners shall benefit of it and shall offer it to their clients. Going step by step, getting trained in training centers, not being too ambitious when getting started are the keys for efficient progresses and successes.


Fiorbianco, V; Skalicky, M; Doerner, J; Findik, M; Dupre, G (2012): Right Intercostal Insertion of a Veress Needle for Laparoscopy in Dogs. Vet Surg (41), 3 367-373.


Univ. Prof. Dr. Gilles Dupré, Dipl. ECVS, Leiter der Kleintier Chirurgie, Department für Kleintiere und Pferde, VetMedUni Vienna, Veterinaerplatz 1
A - 1210 Vienna, AUSTRIA
Tel. Sekret : 43-1- 250 77 – 5301/5302
gilles.dupre@vetmeduni.ac.at
Several techniques have been reported and the main differences are related to the number of ports and to the devices used to perform the ovary and uterus resection. To perform LapOVE the first trocar is usually placed near the umbilicus and the ancillary ports are placed cranially and caudally on the midline. In multiple port techniques the ovary is suspended by a grasping forceps and resected. In alternative, the ovary can be suspended and fixed to the abdominal wall by trans-abdominal suspension sutures, that can allow to eliminate the need of an additional port and reduce the number to two or even to one. To perform single port LapOVE, besides suspension sutures, a so called “operative” or “operating” 10mm 0° laparoscope is used and the grasping forceps and the haemostatic devices can be introduced through its working channel. With this technique, the whole surgery is performed through one cannula. Besides the reduction of the number of ports, LapOVE can reduce the surgical trauma and the operation time in comparison with LOVH or LAOVH.

Laparoscopic ovariohysterectomy has been described with the use of 3 to 4 ports, placed either paramedian or median. A two median ports technique for LAOVH has also been described with the implementation of an operative laparoscope and trans-abdominal suspension sutures. Usually the dissection starts to one ovary, followed by the uterine body and then the second ovary. The uterine body can be closed by stapler, or in small dog with small uterus body by a bipolar vessel-sealing device. In the assisted technique, the ovarian pedicle and mesovarium are resected, and then the ovaries and uterine horns are exteriorised through the caudal port and the uterine
arteries are ligated and the uterine body is transected as in an open technique. The
assisted technique appears to be less time consuming than the full laparoscopic one.
The reported rate of complications for laparoscopic procedures performed in small
animal surgery seems to be very low. Complications can be related to anaesthesia
and capnoperitoneoum, and to surgical procedures. Pneumoperitoneoum increases
the intra-abdominal pressure and causes hypercapnia. A non-diagnosed
diaphragmatic hernia or diaphragmatic perforation can lead to iatrogenic
pneumothorax. Most of reported peri-operative complications are associated with the
blind insertion of either the Veress needle or the first trocar. Potential injuries
comprise abdominal wall and intra-abdominal vessels injuries, penetration of solid
organ, as spleen and liver, perforation of hollow viscus, as intestine or urinary
bladder. Subcutaneous emphysema can also occur after inadvertent insertion
insufflation of the sub-cutaneous space. One case of fatal embolism has been
reported due to insertion of the Veress needle in the spleen. Bleeding of ovarian
pedicle during the procedure has been commonly reported, and in all but one study it
was usually minor and easily controlled and did not require conversion to
laparotomy. Moreover, new instruments as vessel-sealer devices are now widely
used and show better performance and safety. Intra-abdominal burns can occur
when an electro-coagulation instrument is inadvertently activated or when coupling
capacity occurs between the instrument and a metallic cannula.
Post-operative wound complications include omental herniation and seroma. They
have been seldom reported. Swelling, erythema are less likely to occur in
laparoscopic techniques compared to open technique, mainly due to reduced size of
incision. Other complications related to ovariecotmy and ovariohysterectomy
procedures, as urinary sphincter mechanism incompetence or ovarian remnant
syndrome are assumed to be the same as in open surgery.
Despite the overall complications that are related to laparoscopic surgery, laparoscopic sterilization of the bitch is a quick and safe procedure. It offers all the advantages of the mini-invasive approach: Small incision, little post-operative pain, quick release from the hospital. In trained hands it the complication rate is very low and surgical duration compares very favourably with open surgery.

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>↓↓ patient stress and pain</td>
<td>↑ Cost</td>
</tr>
<tr>
<td>↓ surgical trauma (minimized in LapOVE)</td>
<td>↑ Time (beginning of the learning curve)</td>
</tr>
<tr>
<td>↓ post-operative morbidity (minimized in LapOVE)</td>
<td>Ventilator</td>
</tr>
<tr>
<td>↓ recovery time</td>
<td>Need of one assistant at least</td>
</tr>
<tr>
<td>↑ owner satisfaction</td>
<td></td>
</tr>
<tr>
<td>stayed dogs</td>
<td></td>
</tr>
<tr>
<td>↑ magnification of images</td>
<td></td>
</tr>
<tr>
<td>Abdominal exploration</td>
<td></td>
</tr>
<tr>
<td>↑↑ Feasibility and safety with new vessel sealer-divider devices</td>
<td></td>
</tr>
</tbody>
</table>

**Advantages and Disadvantages of laparoscopic spaying techniques**
Following the description of percutaneous arterial catheterization by Sven Ivar Seldinger in 1953, angiography developed into a widely-utilized and essential medical diagnostic tool (for humans). Technological advances have since helped transform this diagnostic modality into a sub-specialization with enormous therapeutic potential. Interventional radiology (IR) involves the use of contemporary imaging techniques such as fluoroscopy and ultrasonography to selectively access vessels and other structures in order to deliver different materials for therapeutic reasons.

ADVANTAGES AND DISADVANTAGES
The use of IR techniques in veterinary patients offers a number of advantages compared to more traditional therapies. These procedures are minimally invasive and can therefore lead to reduced peri-operative morbidity and mortality, shorter anesthesia times and shorter hospital stays. Some less equipment-intensive procedures can result in reduced costs as well. In addition, some techniques such as chemoembolization of tumors or palliative stenting for malignant obstructions offer alternative treatment options for patients with various conditions that may not be amenable to standard therapies.

The primary disadvantages of IR include the required technical expertise, the specialized equipment necessary (fluoroscopy with or without digital subtraction capabilities), and the large initial capital investment necessary to provide a suitable inventory of catheters, guide wires, balloons, stents and coils.

EQUIPMENT AND TECHNIQUE
As most of these procedures are minimally invasive (performed through catheters or small holes in the skin), traditional sterile operating rooms are not required, but recommended. Most of these procedures are performed in clean angiography suites. The entry sites receive a traditional sterile scrub, and operators wear full lead gowns, lead thyroid shields, caps, gowns, and masks. The radiation exposure during conventional or C-arm fluoroscopy can be substantial. The operator should review radiation safety guidelines, minimize exposure time and beam size, and maximize shielding and distance from the beam.

For many of the more commonly performed IR procedures, a traditional fluoroscopy unit is sufficient. A C-arm fluoroscopy unit has the advantage of mobility of the image intensifier, permitting multiple tangential views without moving the patient. Occasionally, ultrasonography is useful for percutaneous needle access into vessels or other structures. Digital subtraction angiography (DSA) and “road-mapping” allow high resolution images to be obtained with minimal use of contrast agent which is often a concern in our relatively small veterinary patients. DSA is required for super-selective angiograms of small caliber vessels and those vessels in the head (or where there is substantial bone which makes angiogram visualization difficult).

CHANGING PARADIGMS
TRACHEOBRONCHIAL STENTING
Intraluminal stenting is a palliative, minimally invasive therapy used for restoration of an obstructed or narrowed lumen. Interventional radiologists have employed these techniques in virtually every accessible lumen of the human body and, if recent history is any indication, it appears it is now the veterinarians’ chance to do the same in our animals. Following even a preliminary review of the human interventional radiology (IR) literature, it does not take a tremendous amount of imagination to conclude our patients can likely benefit from similar procedures as there is such abundant overlap of the disease processes. The respiratory system has the potential to be particularly well suited to these types of interventions as these patients are often severely affected and fragile, comorbidities are not uncommon, and the risk of associated surgical complications from traditional therapies can be relatively high.
Veterinary IR has evolved to encompass many different body systems, each with their own successes and failures. However, even with the advancements in intraluminal tracheal stenting devices and technical modifications, a number of these patients continue to be plagued by complications including intractable coughing, infection, tissue ingrowth, stent fracture, and others. Although these procedures are still not providing the ideal outcomes we might hope for at this time, veterinarians performing this procedure with even some regularity will generally agree that dramatic improvements can be achieved in certain cases that have failed aggressive medical management and surely would have not tolerated a surgical intervention. Clearly there is a role for tracheal stenting in our veterinary patients, and this may expand to bronchial stenting for similar collapse/compression of these structures in certain circumstances.

Stents, Technique, and Outcomes
Over the last decade, tracheal stents have become increasingly available to veterinarians, and their design and delivery systems have evolved accordingly. We have come a long way from the originally described metallic balloon-expandable stents to shape-memory self-expanding metal (and even tapered) stents. Unfortunately, currently manufactured metallic stents remain a long way away from mimicking the complexity of the living trachea. Our human medicine colleagues have described complications including “obstructive granulation tissue, stenosis at the ends of the stent, migration of the stent, mucus plugging, infection, and stent fracture”¹; very similar to some of the major complications identified in our veterinary patients. However, we must interpret this information with an understanding of the different indications and circumstances in humans compared with our patients. Much of the tracheomalacia (TM) treated in humans is temporary so removable stents (silicone) are preferred. In addition, even for permanent indications, stent exchanges and “toilet bronchoscopy” procedures to suction, remove, and reculture infectious mucus accumulations are not uncommon in people with silicone stents; perhaps a limiting factor for routine use silicone stents in our patients due to cost and owner compliance.

Fortunately, it seems self-expanding metallic tracheal stents have better outcomes in dogs compared to those routinely reported in humans for benign diseases. Our problem has been determining which of the canine patients are mostly likely to respond favorably to this treatment, as the current outcomes are widely variable and difficult to predict. Perhaps the most important advancements in my own stenting experiences have been in recognizing the variability of the “tracheal collapse syndrome” (weakened dorsal membranes versus tracheal malformations², for instance) and in refining our stent placement techniques. The technical advancements include improved medical management and recognition of comorbidities, appropriate fluoroscopic technique and tracheal measurements, proper stent diameter oversizing and preventing overlong stents, pre- and post-stent tracheoscopy, and vigilant client communication with regular scheduled follow-up examinations.

Our approach to traditional flattened tracheal lumens (flaccid dorsal membranes) is different from the “W”-shaped cartilage rings seen in tracheal malformation cases. More involved upper airway examinations identifying comorbidities such as overlong soft palates or epiglottic retroversion have led to concurrent airway surgeries performed more routinely in our patients. Performing careful patient positioning and both positive- and negative-pressure ventilation images with esophageal marker catheter placement confirms precise collapse location and minimizes error in radiographic magnification, one of the most common mistakes made during the stenting procedure. Pre- and post-stent tracheoscopy confirms the variety of collapse as well as appropriate stent-to-tracheal wall contact and positioning during the procedure so inappropriately positioned stents can be removed or repositioned while it is still possible.

Although tracheal stenting is one of the first IR techniques veterinarians attempt, it is a demanding technical procedure with little room for error, and advanced training is highly recommended to avoid some of the more common mistakes.

Complications
Fortunately there are some complications we can control; Those include mistakes in case selection, stent choice and technical decisions, inappropriate monitoring, late detection of complications, and poorly executed medical management. Unfortunately there remain some complications we currently cannot easily control; These include granulation or inflammatory tissue ingrowth, infection, stent fatigue and fracture, and disease progression. As stent technology and designs improve in the future, some of these problems may become less of a concern, however in the meantime, appropriate client counseling, early
detection, and aggressive medical management or intervention may reduce the consequences of these complications.

Tissue ingrowth into tracheal stents has been reported in both human and veterinary patients. In animals, any growth within the stent was initially considered “granulation tissue” due to human reports and appearance. More recently, we and others have appreciated tissue regression following high dose corticosteroid administration. We know granulation tissue does not regress with corticosteroids leading us to conclude this is often inflammatory tissue/granulomas rather than granulation tissue. This tissue typically develops at the cranial aspect of the stent but can develop elsewhere. Over the years we have recognized this tissue can respond to high dose steroids when administered early, however when treatment is delayed responses are more uncommon. Rather than granulation tissue “versus” inflammatory tissue developing independently, it appears that the longer inflammatory tissue is present without treatment the more this tissue will become organized and infiltrated with fibrous scar tissue; This what a number of our biopsies have suggested (currently unpublished data). This highlights the importance of regular monitoring and early detection of tissue ingrowth. Further we have recognized that tissue growth adjacent to or within the stent can often be unrecognized due to forelimb positioning in a lateral radiographic projection. For this reason we have instituted mandatory 3-view chest and neck radiographs for all tracheal stent cases with the forelimbs pulled cranially in one lateral and caudally in another. This position permits complete evaluation of the cervical and intrathoracic trachea without interference of the forelimb soft tissue and boney structures.

Infection has been considered a major component of the tracheal collapse syndrome but once a tracheal stent has been placed, it is clear that the trachea becomes susceptible to infections. This is exacerbated when there are persistent gaps between the stent and tracheal wall, permitting mucus accumulation, most commonly seen in the tracheal malformation cases we recently reported. Infections alone can be problematic, however the greater concern may perhaps be the increased risk of tissue ingrowth that occurs when tracheal stents become infected. This is well documented in humans with tracheal stents. It had been unclear whether the tissue ingrowth led to infection or the infection led to tissue ingrowth. More recent data suggests that both infection and stent micromotion independently contribute to the development of tissue ingrowth into the stent. Over the years we have been more aggressive about early intervention of cases with persistent clinical signs; early tracheoscopy and culture permit rapid, appropriate antibiotic therapy. Our impression has been diffuse stent infiltration with tissue is most often associated with infection and appropriate antibiotic therapy can often result in regression. Hesitation to interrogate the problem can lead to inappropriate antibiotic selection, tissue progression and organization/fibrosis, and ultimately require additional stent placement during respiratory crises.

Stent fracture will continue to remain a concern when metallic stents are used. There is no perfect stent; The unforgiving environment and extreme forces encountered are more than we can currently expect a stent to sustain for the many years we are anticipating it to be in place. Super-elastic titanium alloys, special coatings, improved designs, and other technological advances will continue to improve the longevity of these stents. Currently, the most important aspect of tracheal stent fracture in our practice is early detection and restenting prior to patient decompensation. Good outcomes can still be achieved when stent fractures are identified and restented quickly.

Although previous literature cited stent migration and substantial stent shortening as common complications, our experience has not supported these findings (this information is being presented at this conference). When appropriately sized diameter stents are used, migration is almost negligible (as demonstrated by changing distance from stent to cricoid and/or carina) and our stent shortening rates are approximately 11% over the long-term compared to the approximately 30% previously reported. The stent type and diameter used and/or the placement technique likely explain these differences.

Considerations on Bronchomalacia and A Theory of “Bronchial Compression”

Bronchial stenting may be the natural progression of veterinary respiratory endoluminal therapy. The presence of left mainstem bronchomalacia and bronchial collapse has been well reported in the veterinary literature, commonly associated with left atrial enlargement. It has also been reported as an isolated, incidental finding and in dogs with tracheal collapse with or without concurrent heart disease. Interestingly, brachycephalic breeds have also been shown to have unilateral bronchial collapse (84% left-sided) as well – even without the presence of left atrial enlargement; This has been explained due to
chronic abnormal airway pressures leading to progressive weakening and subsequent collapse of the left mainstem bronchus. The unilateral nature remains unclear but theories have included different airway pressures encountered along this longer left bronchial segment when compared with the relatively shorter right mainstem bronchus. This left mainstem bronchomalacia has even been cited as a possible cause for left cranial lung lobe torsions in Pug dogs due to the weakened cartilage integrity. The wide variety of dogs experiencing mostly left bronchial collapse, with or without heart disease, with or without upper airway collapse, and with or without clinical signs suggest a variety of possible explanations, likely important to understand more clearly if we hope to predict outcomes following invasive, or even noninvasive, interventions.

Comparatively, bronchomalacia in humans is typically bilateral and when unilateral, the left and right sides seem generally equally affected for the most part. Anatomical differences between humans, animals, and even different shaped animals (narrow, deep-chested versus barrel-chested breeds) inspired a more detailed investigation into the thoracic anatomy of different breeds. Some examples of this investigation are included in Figure 1 demonstrating the possible “compressive, sandwiching” nature of the left mainstem bronchus between the left atrium and aorta, particularly apparent in barrel-chested dogs (not uncommon conformations of brachycephalic breeds and some of the at-risk collapsing trachea breeds including barrel-chested Yorkshire terriers). A static compression of the bronchus could lead to cartilaginous weakness and further collapse over time, progressing from “static” to “dynamic” compression. This phenomenon could explain why some bronchoscopically-identified bronchial compression is “static” or “fixed” (as might be identified with compression between two structures) versus “dynamic” (as might be expected with malacia of the cartilage during dynamic airway pressures). In fact the bronchial collapse described in the brachycephalic breeds was described as “fixed” in 87.5% of the dogs. The location of the pulmonary arteries may also contribute to airway compression and could even help explain the narrow pedicle of the left cranial lung lobe in Pug dogs and possible predilections to bronchomalacia, regional atelectasis, torsion, or combination. The more typical compression of the left mainstem bronchus may even be another possible explanation for the more commonly located right-sided (46%) bronchial versus left-sided (29%) bronchial airway foreign bodies in dogs. Figure 1 demonstrates just some of the wide variability of cardiovascular and airway structures positioned in different breeds, as well as individual dogs within a breed. If “bronchial compression” is confirmed in certain breeds and/or thoracic conformations, this might help determine which patients may benefit from bronchial stenting; It may also help determine which patients might not.

This information is preliminarily under investigation at our institution but further characterization of anatomical differences between breeds, anatomical conformations of vascular and respiratory structures, and even gestational growth patterns leading to cartilage weakness and future collapse could provide useful information for our patients in the future. Much work needs to be done to determine which patients may benefit from bronchial stenting. Personally I feel there will be a subset of patients that will benefit and others that will not; How we will categorize these patients remains to be determined and will likely take the work of many researchers around the world for years to come.

Figure 1: Serial, static, axial thoracic CT images in 4 dogs without cardiac or pulmonary disease. Note the variable thoracic width (red line) and depth (blue line) conformations and corresponding cardiovascular structure locations (A-Aorta, RB-right bronchus, LB-left bronchus, LPA, left pulmonary artery). A. Deep-chested Boxer with considerable space between thoracic vertebral body, aorta, and left bronchus. B. Intermediate barrel-chest conformation Pug with left bronchus compressed between aorta and heart. Note the lack of available space between the thoracic vertebral body, extremely dorsally located aorta, and the left bronchus. The right bronchus is free of compression from any cardiovascular
structures. C. Intermediate barrel-chest conformation Yorkshire terrier with left bronchial compression between aorta and heart. The right bronchus is free of compression from surrounding structures. D. Severely dorsoventral flattened thoracic conformation in a French Bulldog with a retrobulbar sarcoma and no respiratory signs having thoracic CT for metastasis screening. Note considerable left bronchus compression between aorta and the left-sided deviated heart with additional compression from the left pulmonary artery.

CONGENITAL IHPSS AND HAVM

The categorization of liver vascular anomalies is often confusing and but the most recent classification suggests three separate categories of liver vascular disease: (1) Congenital portosystemic shunts (IHPSS and EHPSS), (2) Disorders associated with abnormal hepatic bloodflow or portal hypertension, currently termed Primary Hypoplasia of the Portal Vein (PVH), and (3) Disturbances in outflow. The second category (PVH) remains the most confusing, and includes processes that may or may not result in portal hypertension. These are termed PVH with portal hypertension and PVH without portal hypertension. Examples of PVH with portal hypertension include non-cirrhotic portal hypertension (NCPH), and hepatoportal fibrosis/veno-occlusive disease. PVH without portal hypertension was previously termed microvascular dysplasia (MVD).

IHPSS (and EHPSS): Single, extrahepatic PSSs are amenable to relatively uncomplicated surgical attenuation, however surgical repair of intrahepatic PSSs are consistently more challenging. Numerous techniques have been described for intrahepatic PSS attenuation, however morbidity and mortality rates can be very high, even for the most experienced surgeons. The goal of IR techniques for IHPSSs is to reduce the unacceptably high, peri-operative mortality rates associated with traditional open surgical techniques and hopefully improve the outcome for these cases. The author has performed over 100 percutaneous transvenous coil embolizations (PTCE) with a vena caval stent and thrombogenic coils placed within the shunt. Peri-operative complications were mostly minor and peri-operative mortalities were comparatively low versus that reported for traditional surgery.

LESSONS LEARNED:

-A certain small population of IHPSS patients have "significant" portal/systemic venous pressure gradients (or resting portal pressures) before treatment. This is counter-intuitive in animals with PSS in that reduced portal pressure gradients would be anticipated, and this has prevented treatment in some cases. Are there small vascular windows or narrowings present that are not identified on cross sectional imaging with relatively wide slices? This suspicion has been raised as pull-out pressure tracings confirm short, focal areas where pressure gradients exist. The presence of a developed portal system may suggest a narrowing of the shunt in some location making access more difficult. This may be the same for EHPSS suggesting intermittent shunt compression in phrenic shunts for instance!!

-Which is more important in preventing the development of complications associated with portal hypertension following IHPSS treatment; Total portal pressure or pressure gradients? During surgery we rarely measured CVP and using IR techniques, we always measure CVP.

-During portography, when multiple small intrahepatic shunts are identified, this is almost exclusively associated with and elevated portal pressure and/or pressure gradient. Are these congenital shunts or acquired IHPSS resulting from a congenitally narrowed IHPSS?

-Acquired Intrahepatic Portosystemic shunts: Originally believed to only acquire EHPSS, there is more evidence that IHPSS can be acquired as well. Do the same criteria for shunt attenuation (no greater than ~10cmH2O rise in portal pressure and/or no greater than ~20cmH2O total portal pressure) hold for attenuation of IHPSS? Although there is no documented difference between HV attenuation and PV attenuation, the vascular bed receiving the congestion is intrahepatic with the former and extrahepatic with the latter. Does this matter?

-DO NOT PERFORM IHPSS SHUNT ATTENUATION IN THE FACE OF GI ULCERATION/HEMORRHAGE. The authors currently perform endoscopy and biopsy of all IHPSS cases before treatment and the overwhelming majority of these dogs have some degree of inflammatory bowel disease, sometimes including GI ulceration. Approximately 17% of patients have evidence of GI bleeding before treatment. Elevation of portal pressures with the presence of GI ulceration can lead to severe GI hemorrhage and death. All animals are maintained on omeprazole therapy for life. Initially a long-term mortality rate of 30% in IHPSS PTCE animals was caused by GI bleeding in ~50% of deaths. Lifelong antacid therapy has reduced the mortality rate to 12.5% with fewer than 4% secondary to GI bleeds. Is lifelong omeprazole therapy safe?
**HEPATIC AVMS:**
Vascular malformations have been classified as high-flow or low-flow, and as arterial, venous, lymphatic, or mixed. They are often associated with tumors but can also be seen congenitally in the liver (hepatic AVMs). Once called arteriovenous fistulas, they have been more recently termed arteriovenous malformations due to their vascular anatomy upon angiography. Interventional radiology techniques have allowed us to improve our understanding of these particular AVMs in terms of their vascular nature, response to treatments (glue embolization), and resulting pathophysiology. The observations below have been made following surgery or glue embolization of 20 HAVMs.

**LESSONS LEARNED:**
- It has been suggested in the human literature that while AVFs can be ligated or coil embolized, multiple AVFs or AVMs should receive glue embolization (or alcohol ablation) in order to destroy the nidus that will otherwise recruit additional vessels over time. This has not been confirmed in the veterinary population but angiograms shown may support this notion.
- Initial angiography (and cross sectional imaging) often underestimates the extent of the disease. Following initial embolization, additional previously unidentified contributing vessels open up demonstrating the true infiltrative nature of these vascular anomalies.
- Complete HAVM embolization or resection appears to be required to prevent recurrence. Incomplete embolization or resection will lead to revascularization if the HAVM nidus remains.
- These patients can tolerate complete hepatic artery embolization and the cyanoacrylate glue appears to be permanent in the cases that have been followed to date, although the radio-opacity of the glue (Tantalum and Lipiodol) may diminish over time.
- Although return to hepatopetal portal bloodflow (towards the liver) would be considered the goal, this has not been seen in any of the cases treated to date. Acquired EHPSS are present in ALL patients and can be expected to remain in place providing the least resistance to portal bloodflow. Complete HAVM embolization could conceivably result in stagnant portal bloodflow as the direction changes from hepatofugal to hepatopetal and near complete stasis has been identified but to date has not required intervention.
- Vascular contributions to the HAVM are not only from the hepatic artery but have also been identified to arise from the gastroduodenal artery, left gastric artery, and phrenic aa. Performing an aortogram following embolization is recommended.
- GREATEST HOPE for successful treatment may be dominant outflow vein (DOV) embolization!!

**THROMBOSIS/THROMBECTOMY/THROMBOLYSIS**
Advanced imaging techniques, the management of extremely debilitated patients with a host of hypercoagulable risk factors, and the growing use of indwelling catheters and medical devices will likely increase the number veterinary patients identified with clinically detectable thrombosis. While many of these patients will not require intervention for these problems, a growing proportion will as the underlying disease processes are now being better managed. The most common underlying diseases to investigate in a complete evaluation include cardiac, endocrine, inflammatory, hepatic, renal, and neoplastic processes. In addition, idiopathic thrombosis can also occur when an underlying condition is not identified. The complete diagnostic work-up for a patient with thrombosis is beyond the scope of this lecture, which will focus primarily on interventional management options when the clinician feels they are indicated. Standards-of-care have not yet been determined or evaluated in veterinary patients with symptomatic thrombosis so the procedures discussed are based solely on the author's experience.

**Interventional Radiology Treatment Options**
The failure of medical therapies to be effective alone, combined with the overall high morbidity associated with surgical thrombectomy in hypercoagulable, sometimes post-surgical patients soon to be receiving anti-coagulation, makes minimally-invasive treatment options a reasonable consideration in many of these patients. The excitement associated with performing these procedures must not overshadow the most important part of the therapy; The underlying condition must be addressed and the hypercoagulable state must be resolved or any intervention is likely to fail. Any intervention meant to treat these problems must be associated with a comprehensive medical plan to manage the underlying disease process and hypercoagulable state prior (if possible) to the intervention. This means aggressive
anticoagulation and antiplatelet therapy if indicated. Recently available human oral anticoagulation (Rivaroxaban) may facilitate this process in animals as well.

Arterial Thromboembolism

Arterial obstructions often present with more severe clinical signs depending upon the amount of tissue risking devitalization. Peripheral arterial thrombi are less commonly diagnosed in veterinary patients, likely due to the vast and abundant collateral perfusion throughout much of the body. The classic arterial thromboembolism scenario in veterinary medicine is the saddle thrombus occluding unilaterally or bilaterally the pelvic limbs. In severely affected animals the attending clinician often does not have the luxury of time to see if systemic anticoagulation and/or lytic therapy will be effective. Historically, surgical thrombectomy has been performed and rheolytic thrombectomy has been described. Both techniques are effective but unfortunately the underlying cardiac disease and fragile systemic condition of the patient often results in poor longer term outcomes in approximately 50% of the patients. In addition, acute reperfusion of both pelvic limbs would be associated with malpractice litigation if performed in humans due to the anticipated risk of death from reperfusion injury. Before performing such a procedure the attending clinician should have a long conversation with the pet owner about such a sequela. It has been the author’s experience that dogs (and likely cats) can likely tolerate occlusion of both the internal iliac arteries without clinical signs. Once the thrombus grows and extends beyond this bifurcation, clot begins travelling down the external iliacs arteries and into the femoral arteries. This is the point of clinical presentation. As long as both external iliac arteries can remain patent the animal can recover. The use of infusion thrombolysis with vascular stenting has been successful in a small number of these patients treated by the author. This technique appears to provide a more delayed reperfusion than the hyperacute reperfusion encountered during complete clot removal.

Interestingly, the author has recognized more chronic distal aorta thrombi in dogs between the renal and external iliac arteries; the chronicity is identified by collateral circulation and the clinical signs associated with claudication rather than acute hindlimb ischemia. These patients should not be “lumped in” with saddle thrombi patients. These patients can respond to vascular therapy very well as the risk of acute reperfusion injury is not expected. Aggressive and early physical therapy should be performed as the author has seen muscle contracture following arterial ischemia the pelvic limb in a dog.

Venous Thromboembolism (VTE)

Treatment of venous thrombi must be based upon consideration of the overall clot burden and extent, the resulting clinical signs associated with the venous obstruction, and the ability to control the underlying cause of the clot if it is known. In addition, one of the most problematic complications in humans with venous obstruction is “Post Thrombotic Syndrome (PTS)”, a group of conditions including swelling, pain, skin ulceration and discoloration resulting from chronic untreated DVTs. The cause is unclear but likely associated with chronic inflammation and damaged venous valves. We are unclear if this occurs in animals. The major goals of VTE treatment include resolution of clinical signs, avoidance of PTS, and reduction in risk of PTE. While anticoagulation and systemic thrombolysis continues to play a predominate role in VTE, catheter-based techniques may help improve outcomes when considering the goals stated above. These techniques are generally divided into three categories including (1) Passive infusion of thrombolytics into the clot through infusion catheters called “catheter directed thrombolysis (CDT), (2) “Percutaneous mechanical thrombectomy (PMT)” involving mechanisms of clot aspiration and maceration, and (3) Lytic-assisted devices providing pharmacomechanical and sonically enhanced thrombolysis techniques.

CDT is technically easy and relatively inexpensive to perform however improved outcomes have not yet been documented and prolonged infusion times and increased risk of bleeding are the problems. PMT provides an elegant approach and have been demonstrated to work well with hyperacute thrombi, however they tend to fail short in more chronic thrombi that are 2-3 weeks old. The lytic-assisted devices are the new frontier and work well in smaller vessels, however larger vessels may also require adjunctive CDT or vascular stenting.

Venous stenting is often employed in processes in which the large veins may be externally compressed lading to recurrent thrombosis however stent are often avoided at the confluence of veins or in the limbs where stent fracture and other complications can occur. Stenting has been employed more often at the author’s institution due to the relative ease and rapidity of placement, immediate resolution of clinical signs, and general chronicity of most of the clots encountered in our practice.
Similar techniques are currently being employed to manage ureteral obstructions secondary to stones, strictures, or malignancies. These procedures can be performed surgically or with minimal invasiveness (percutaneously or via cystoscopy) to reduce morbidity and improve outcomes in certain patients.

**INTERVENTIONAL ONCOLOGY**

A variety of interventional techniques are being explored to contribute to care of the veterinary oncology patients. Some of these techniques will be reviewed.

REFERENCES UPON REQUEST
Interventional endoscopy (1)
1. Nasal & sinus surgery
2. Otoendoscopy: The endoscopic approach to the middle ear

Gerhard Oechtering
University of Leipzig, Veterinary Faculty, Small Animal Department, ENT-Unit
Leipzig, Germany

1. Nasal & sinus surgery

Endoscopic Approach to the Nasal Sinuses in Dogs and Cats

Introduction
Modern tomographic imaging techniques uncover diseases of the paranasal sinuses more often and much more detailed. The conventional surgical approach to the paranasal sinuses is well defined. Alternatively, paranasal sinuses are endoscopically accessible. The endoscopic procedure has various advantages for diagnostic and interventional procedures as well:

1. It is minimal invasive approach.
2. Advancing though the nasal cavity allows a thorough inspection of neighbouring nasal tissue that is often involved primarily or secondary in the disease process.
3. The unique magnification of modern endoscopes provides additional information and allows very precise collection of biopsies.
4. It creates a well-positioned opening for drainage after the intervention.

Endoscopically these paranasal sinuses are accessible:

1. Sinus frontalis
2. Sinus ethmoidalis (cat, and functionally dog)
3. Recessus maxillaris (dog)

Indications
1. Sino-nasal Aspergillosis
2. Sinusitis of other origin
3. Ethmoidal Cysts
4. Foreign bodies
5. Neoplasias (benign/malign)

Equipment
For several reasons we perform predominantly these procedures with rigid endoscopes. They provide a larger and clearer view. Various instruments (suction pipe, forceps) can be introduced slightly before and parallel to the endoscope. This allows bimanual manipulation of tissues and foreign material. Flexible tubes and catheters can be guided in certain directions and locations. The advantage of flexible scopes is clearly their high manoeuvrability. They allow access to difficult areas like the caudal compartments of the frontal sinus.

1. Rigid Endoscopes (Hopkins optic, Karl Storz):
   a. 1.9 mm 0°, 30° & 70° (small dogs & cats)
   b. 2.7 mm 0°, 30°, 45° & 70°
2. Flexible Videoscope (Flex-X C, 8.5 Fr., Karl Storz)
3. Tubes and catheters
4. Biopsy and grasping forcepses
5. (very helpful: on-site CT or MRI image access
optional: Navigation system)

Planning
The path into the sinuses needs to be planned precisely prior to the procedure, as manipulation is
done close to vital tissues such as brain and eyes. This can be either done by thorough studying
presurgical CT/MRI scans or with a navigation system such as Storz Surgical Cockpit. Good anatomic
knowledge of the area is vital in order to not harm surrounding tissues.

Access
The physiologic connection between nasal fossa and frontal sinus is not accessible for an endoscopic
entry. We use an approach after direct perforation of the dorsal concha into the frontal sinus. The
precise location is determined in the sagittal CT reformation, measuring the distance from the nares
to the desired point for perforating the dorsal concha. In some dogs suffering from sino-nasal
aspergillosis access to the paranasal sinuses may be easy due to conchal destruction. Usually this
perforation is closed after a few weeks.

Limitations and disadvantages
The endoscopic approach and especially interventional endoscopic procedures needs a good
anatomic knowledge and powers of spatial imagination. Manual skills, particularly for bimanual
interventional working is essential but can be trained using cadavers.

2. Otoendoscopy: The endoscopic approach to the middle ear

Evolution of the otoendoscopy in the middle ear surgery: From an additional to a
primary procedure

Overview of the Issue
Interventional otoscopy allows new specific diagnostic and treatment options and a reduction of
invasive conventional surgical procedures. Advanced diagnostic imaging like computed tomography
in combination with modern videoscopic equipment expands the field of indications for minimal
invasive procedures in the ear.

The medial part of the external auditory canal, the tympanic membrane and the tympanic cavity
including its opening into the nasopharynx can be assessed easily with appropriate rigid endoscopes.
Modern video-otoscopy in combination with interventional techniques allows very precise specimen
collection and biopsies as well as minimal invasive surgery within an area that was not easily
accessible so far.

Diagnostic procedures
1. Examination of the medial part of the external auditory canal, the lateral surface of tympanic
membrane. The latter is translucent and may allow a visual impression of the
mesotympanum.
2. After tympanocentesis or in cases with perforated tympanic membrane it is possible to
examine dorsally: the epitympanum (epitympanic recess) with the auditory ossicles,
medially: the mesotympanum with tympanic membrane and the opening of the auditory
tube that connects to the nasopharynx and ventrally: the hypotympanum with the mucosa of
the tympanic bulla. In the literature a classification solely between cavum tympani proper and epitympanic recess is also described.

**Therapeutic procedures**

1. Specimen collection and flushing in infectious and inflammatory diseases of the middle ear,
2. Inflammatory polyps of the bulla in cats, extraction and subsequent "cleaning" of the tympanic bulla.
3. Neoplastic diseases, exploratory excision

**We use the following equipment**

1. In small animals there is an extraordinary wide range of anatomic diversity in size and shape between the different breeds. Correspondingly a wide variety of equipment can be necessary for interventional procedures.
2. Rigid endoscopes with a diameter between 1.9 and 2.7 mm and a view from 0° to 70° for the ear and 120° for the nasopharynx, with and without shaft.
3. Rigid and flexible suction and flushing pipes, cannulas and catheters from 0.8 to 2.5 mm
4. Various biopsy and grasping forcepses
5. Special extensions for HF-surgery and laser applications

**Practical approach**

If involvement of the middle ear is suspected, a computed tomographic examination prior to endoscopy is very beneficial and helps to assess extension and quality of the disease process.

A retrograde pharyngoscopy should always be performed prior to otoscopy to assess the nasopharyngeal opening of the auditory tube for any signs of discharge.

If there is no clear view of the tympanic membrane the external ear canal is cleaned by a combination of cautious suction und flushing. Squalen may be used as ceruminolytic agent.

Two principally different working methods are

- Working THROUGH the channel of the endoscope shaft with suction and forceps or
- Working PARALLEL to the endoscope with various devices

A combination of both is also possible.

The "parallel-to-endoscope-technique" has several advantages:

1. allows acting without shaft thus gaining considerably more space in the depth of the operating field
2. working with two separate angles (i.e. endoscope and forceps) allows much better manipulation of tissue

**Disadvantage of this technique:**

1. needs definitely more manual skill and training
2. thin endoscopes without the protection of a shaft are more prone to damage because of a low buckling strength

**Tympanotomy:** An 18G flexible IV catheter is best used for specimen collection in case of secretion within the tympanic bulla. Positive collection can be visualized through the transparent catheter. Tympanotomy should, if possible, be performed without prior flushing of the ear canal because flushing agents may disturb cytologic examination. Specimen can be examined bacteriologically, cytological and pathohistologically if indicated.

Sometimes, secretion is too viscous to be collected through this catheter. In such cases, collection can be tried through a larger bore metal suction pipe. If necessary, material inside the bulla can be mobilized by a combination of flushing and suctioning with a small metal cannula. Blunt trauma of the tympanic membrane will usually heal within two weeks, if no infection is present.

Polyps can be resected with a traction-method with forcepses. Goal should be a tympanic wall cleared of all granulation tissue. In cases the second compartment of the tympanic bulla is filled with polypous tissue as well, the septum bullae can be driven through. Rarely, a VBO will be necessary if care is taken to remove all granulomatous tissue. Bleeding usually terminates as soon as all
granulomatous tissue is removed. Always owners should be informed about the possibility of Horner’s syndrome upfront.

Polyps growing through the auditory tube into the nasopharynx can be best removed under retrograde endoscopic control.

**Flushing/Irrigation:** In case of otitis media or interna, the middle ear can be flushed with attenuated antibiotic solution. Patency of the auditory tube can be checked with simultaneous retrograde pharyngoscopy.
Interventional endoscopy (2)
Diagnostic and therapeutic endourological procedures -
Laser ablation of ectopic ureters and laser-lithotripsy

Gerhard Oechtering
University of Leipzig, Veterinary Faculty, Small Animal Department
Leipzig, Germany

Advances in ectopic ureter management in dogs

Ureteral ectopia is the most important cause for urinary incontinence in the young female dog. There is a wide range within the degree of incontinence caused by this congenital anomaly of the urinary system. Constant leakage of urine may be associated with regular urination, depending whether a single or both ureteral orifices are displaced caudally to the urinary bladder. In spite of the fact that both female and male dogs are affected the clinical symptoms are much more pronounced in females.

The first diagnostic goal is to rule out other obvious causes of urinary incontinence (complete urinalysis and urine culture). Standard radiographic and/or sonographic examination may also help to rule out other underlying causes. The second diagnostic goal should be the visualisation of the ureteral orifices that may either be in the right place - "in topos" - within the trigon or outside the right place - ectopic - usually distal to the urinary bladder inside the urethra or the vaginal vestibule. Over the years, advanced imaging techniques have been developed to achieve improved visualisation of the ureteral course and orifice. Today a combination of Contrast Computed Tomography and urethroscopy seem to provide the most detailed information. Luckily in most situations endoscopy alone provides sufficient information for a reliable diagnosis.

Over the years it became more and more apparent that incontinence in these dogs can be more than a simple by-pass problem. Unfortunately, ectopic ureters are often associated with other complex anatomical malformations (among others: short urethra, urinary sphincter mechanism incompetence (USMI), primary or secondary abnormalities like hydronephrosis or hydroureter). Some of them can contribute significantly to urinary incontinence. As a consequence, our third diagnostic goal should be to evaluate other possible contributing factors to incontinence, keeping in mind that in the majority of cases this goal cannot be achieved sufficiently. And this problem constitutes simultaneously our first goal for the client information. The owner must be informed that concurrent structural or functional abnormalities of the urinary system may impede success of any surgery correcting the displacement of the ureteral orifices; and on top of that we may be unable to clarify this situation prior to surgery.

The therapeutic plan includes several surgical options. Common to all of them is the goal of re-establishing urinary flow into the bladder. The traditional surgical approach is via an open laparotomy, cystotomy and ureterotomy, sometimes also combined with an urethrotomy. The minimal invasive approach uses interventional transurethral cystoscopy for laser-assisted ablation of the ectopic ureter. Specifically the medial wall of the ectopic ureter is transected with diode laser energy (980 nm) under direct visual control, thus moving the misplaced outlet of the ureter to a level proximal to the urethral sphincter into the lumen of the bladder. When working with this type of laser the surgeon must know and understand the tissue penetrating properties of 980 nm laser light in order to avoid any potential pitfalls of unwanted collateral damage to the urethral tissue.

Holmium:YAG devices are another type of laser used in small animals, mainly for lithotripsy of urinary calculi. This specific wave-length (2100 nm) also has tissue-cutting properties and this laser can be used for surgery of ectopic ureters as well. However, one has to keep in mind that here the manner of tissue dissection differs considerably from that of a diode laser. The mechanical pulses of
this laser resemble to some extent the action of a small pneumatic hammer and this needs getting used to.

The advantages of endoscopic laser ablation are evident. Key diagnostics and surgical therapy are carried out entirely during one single anaesthesia. Therapeutic intervention can start immediately after confirming the tentative diagnosis. The patient can remain in the same position throughout the whole procedure. The only tissue lacerated is the thin superfluous ectopic ureteral wall and usually the animal can be treated as an outpatient.

Urethral obstruction

Urethral obstruction can be either functional or mechanical. The consequences depend on whether the obstruction is acute or chronic and partial or complete. Untreated obstruction may be life-threatening and possibly leads to uremia and death within days. Incomplete obstruction can result in prolonged bladder distension and subsequent functional disorders. Clinical signs range from stranguria to the complete inability to urinate.

Intraluminal urethral obstruction may result from calculi, neoplasia, polyps or trauma with subsequent acute swelling, granuloma or stricture formation after wound healing. Reasons for urethral trauma can be surgery, urethroliths, external trauma or urethral catheterization.

The diagnostic plan is influenced by the anamnestic information and depends on available technical means ranging from laboratory examinations over various options of diagnostic imaging techniques to the endoscopic examination. This talk focuses on potentials and limitations of interventional endoscopy. It is important to note that endoscopy of the lower urinary tract allows both diagnostic evaluation and, when indicated, immediate interventional therapy during the very same anaesthesia and without changing the patient's position.

Because of the distinct anatomical differences between the female and the male dog the indications, equipment and limitations diverge clearly between the sexes. Common to both is the necessity for general anaesthesia and the use of devices for constant irrigation and intermittent suction. Whilst in the female dog the complete lower urinary tract can be easily explored with rigid endoscopes, in the male these instruments allow solely the examination of the very distal urethra – depending on body size – up to the distal or proximal end of the penis bone. Examination of the complete male urethra and the urinary bladder requires a small flexible endoscope, preferably with a digital optical system. The rigid endoscopes needed for urethro-cystoscopy are mostly usable also in other endoscopic procedures (ENT examinations, arthroscopy).

Urethrolithiasis in female dogs. The female urethra is less often obstructed by calculi as it is in male animals; only large stones can block close to the distal urethral orifice. Usually they can be flushed back into the bladder, either directly or using retrograde urohydropropulsion. On the one hand, these stones can be removed surgically, performing either conventional laparotomy and cystotomy or a minimal invasive abdominal approach. On the other hand, they can be treated transurethrally by an interventional endoscopic approach using laser energy for intracorporeal fragmentation.

Among the various types of laser energy the holmium:YAG laser has proven best for lithotripsy. With an infrared wavelength of 2100 nm the emitted light has properties of tissue cutting and coagulation and what is noteworthy is its ability to fragment solid material when the transmitting fibre is in direct contact or near-contact. If the distance between fibre tip and stone is larger, the energy is readily absorbed from water. This characteristic makes the technique relatively safe for the adjoining bladder tissue. At the end of lithotripsy the fragments can be voided after flushing the urinary bladder or extracted with the assistance of a stone-basket.

While the fragmentation of stones is more or less easy to perform, the cloven hoof of the procedure is the removal of larger fragments through the urethra without lacerating the mucosa with the often
razor-sharp fracture lines. Initially, we performed fragmentation by splitting the stone into two larger halves, those into quarters and so forth. The smaller the fragments are, the easier they are blown away by the first laser pulse and disappear from the fibre tip too fast. Meanwhile, we have changed our technique and we now try to ablate the surface of the stone in such a way that we always try to keep it in one single piece and that the ablated material is gravel-like. This is comparable to a continuous peeling of the surface until the whole stone is crumbled. A stone basket can be helpful but is not suitable in very small patients.

**Urethrolithiasis in male dogs.** Here the usual location of stones is caudal to the penis bone, often wedged in the bony U-shaped end. If cautious catheterisation is not able to mobilize the stone, further efforts should be discontinued in order to avoid additional traumatisation of the urethral mucosa and the situation should be explored with an appropriate rigid endoscope. To achieve a clear view irrigation with saline is necessary, either down the working channel of a shaft or, if the lumen of the urethra within the penis bone is too small for working with a shaft, through a thin flexible catheter advanced parallel to the endoscope. I can be tried to mobilize the stone under visual control manipulating devices, again either passed though the working channel of the shaft or parallel to the endoscope. If this isn’t successful, laser lithotripsy is the method of choice to proceed. Energy settings and pulse frequency should be very low in order to protect the adjacent mucosa. Pulse duration should not be too short because stretching of the pulse duration possibly reduces collateral mechanical tissue damage. A sufficient saline irrigation rate helps to abduct thermal energy.

**Urethral stricture.** Common cause of acquired urethral strictures is a constricting wound healing after various types of trauma (i.e. surgery, blocking uroliths, catheterisation and accidents. There are various recommendations how to treat this condition, ranging from balloon dilatation and stent implantation to surgical excision. Interventional endoscopic laser application is also very suitable to treat this condition, even in smaller patients. The specific wavelength of a holmium:YAG laser makes this type of laser energy superior to the diode laser because there is less tissue penetration i.e. less collateral tissue damage and the reopening force is primarily of mechanical nature and less thermal.